PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-258600

(43)Date of publication of application : 24.09.1999

(51)Int.Cl. G02F 1/1335
F21V 8/00

(21)Application number : 10-058181

(22)Date of filing : 10.03.1998

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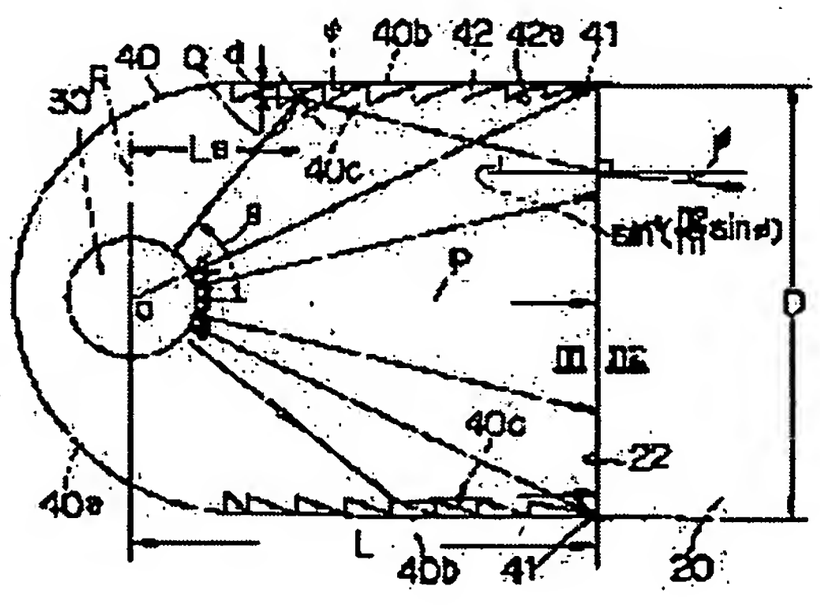
(54) SURFACE LIGHT SOURCE DEVICE FOR LIQUID CRYSTAL PANEL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface light source with such a structure that hardly exerts thermal influence on liquid crystal in a liquid crystal panel by limiting a range of an incident angle to an incident end face of a light guide plate so that a mutual reflection frequency of light in the light guide plate is suppressed to the minimum.

SOLUTION: A reflector 40 has both prism arrays 40c. Each of the prism arrays 40c is provided with plural rectangular prisms 42, and each rectangular prism 42 has a tilted reflecting surface 42a reflecting light of a cold cathode ray tube 30 onto an incident end face 22 of a light guide plate 20. Here, a tilt angle ψ of each reflecting surface 42a is set so that a mutual reflection frequency of the light reflected by each reflecting surface 42a and made incident on the incident end face 22 is suppressed to the minimum.



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[Kind of final disposal of application other than the examiner's decision of rejection or

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CLAIMS

[Claim(s)]
[Claim 1] The tubing light source which is arranged in the incidence end face (22) of the light guide plate (20) arranged along the rear face of a liquid crystal panel (10), and this light guide plate, and carries out outgoing radiation of the light to a radial (30), Are the reflector arranged so that the tubing light source concerned might be covered in the shape of cross-section abbreviation for U characters in accordance with the shaft orientations of this tubing light source, and it has the reflector (40) which incidence is carried out and reflects light from said tubing light source. In the surface light source equipment which said light guide plate introduces the light which carries out incidence to said incidence end face from said tubing light source and said reflector, and was made to carry out incidence to said liquid crystal panel from the rear face as sheet-like light In each internal-surface section which counters mutually among the internal surfaces of said reflector It is prepared so that an optical-system array (40c, 40d) may arrange two or more letter reflectors of an inclination (42a) in the shape of a saw-tooth wave in the direction which intersects perpendicularly with the shaft of said tubing light source, respectively and may become. Said each letter reflector of an inclination inclines so that the light from said tubing light source to said reflector may be turned to said incidence end face and it may reflect. So that this incident light may restrict the count by which an interflection is carried out within said light guide plate to the minimum, when incidence of the reflected light by said each letter reflector of an inclination is carried out to said incidence end face Surface light source equipment for liquid crystal panels with which the tilt angle of each of said reflector is characterized by being set up according to the width of face of said incidence end face, and the distance from the incidence end face concerned.
[Claim 2] It is surface light source equipment for liquid crystal panels according to claim 1 which said each optical array consists of two or more prism (42) which is arranged in the direction which intersects perpendicularly with the shaft of said tubing light source, and has said letter reflector of an inclination, respectively, and is characterized by the letter reflector of an inclination of each [these] prism (42a) having said tilt angle according to the array location of each prism concerned.
[Claim 3] Surface light source equipment for liquid crystal panels according to claim 1 characterized by being the optical interference component for which said each optical array has two or more letter interference fringe sides of an inclination equivalent to said two or more letter reflectors of an inclination (43).
[Claim 4] Said each optical array is surface light source equipment for liquid crystal panels according to claim 3 characterized by being a diffraction grating or a hologram.
[Claim 5] Said liquid crystal panel is claim 1 characterized by coming to enclose a smectic liquid crystal thru/or surface light source equipment for liquid crystal panels of any one publication of four.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the surface light source equipment suitable for adopting it as the liquid crystal panel using the liquid crystal which is easy to be influenced of heat, such as a smectic liquid crystal.
[0002]
[Description of the Prior Art] Conventionally, in this kind of surface light source equipment, a light guide plate is arranged along the rear face of a transparency mold liquid crystal panel, the tubing light source is arranged along with the incidence end face of this light guide plate, and there are some which were made to carry out incidence of the light which carried out incidence from that incidence end face into the light guide plate to a liquid crystal panel as sheet-like light from this tubing light source. Moreover, a reflector is arranged so that the tubing light source may be covered, and usually the reflex action of this reflector has raised the incidence effectiveness into the light guide plate of the outgoing radiation light of the tubing light source.
[0003]
[Problem(s) to be Solved by the Invention] By the way, although the luminance distribution according to the sheet-like light of a light guide plate with the above-mentioned surface light source equipment covers the whole rear face of a liquid crystal panel and can be made into homogeneity, its utilization factor of the light by which incidence was carried out into the tubing light source is low. If it inquires in a detail per this point, the light of the tubing light source will carry out outgoing radiation to homogeneity at a radial covering the direction of 360 degree a core [the axial center of the tubing light source]. Moreover, after it carried out incidence to the incidence end face of a light guide plate or being directly reflected by the reflector, incidence of the light which carried out outgoing radiation from the tubing light source in this way is carried out to the incidence end face of a light guide plate.
[0004] Here, the angle of the direction of incidence of the light to the incidence end face of a light guide plate and the normal to the incidence end face concerned to make, i.e., an incident angle, is determined by the space position relation between the tubing light source and the incidence end face of a light guide plate, the area of the incidence end face concerned, and the property of a reflector. Moreover, the optical diffusion-process layer is usually formed in the base of a light guide plate for equalization of the above-mentioned sheet-like light. Therefore, the light which carried out incidence from the incidence end face into the light guide plate progresses, while an interflection is carried out also to that of a diffuse reflection operation of the above-mentioned optical diffusion-process layer within the light guide plate concerned.
[0005] In such a process, the quantity of light decreases every several% per the interflection. Therefore, the count of an interflection of the light within a light guide plate also increases, and the reduction degree of the quantity of light in the light guide plate concerned is also so remarkable that the above-mentioned incident angle is large. Consequently, light reaches even in the center of a travelling direction of the light of a light guide plate concerned substantially. Therefore, the decrement of that quantity of light will be absorbed within a light guide plate among the light which carried out incidence into the light guide plate, it will be changed into heat energy, and this heat energy has become the factor which has a bad influence on the liquid crystal of a liquid crystal panel.

[0006] Moreover, within a light guide plate, there are so many counts of an interflection near the incidence end face that the above-mentioned incident angle is large. For this reason, the reduction degree of the quantity of light [/ near the incidence end face of a light guide plate] is high. Therefore, within a light guide plate, the conversion rate to the heat energy of light is as high as [near the incidence end face]. Therefore, the part nearer to the incidence end face of a light guide plate has the larger degree of the bad influence to the liquid crystal of heat energy among liquid crystal panels.
[0007] Furthermore, when the above-mentioned diffusion-process layer consists of a printing layer of for example, white ink, light is absorbed by the printing layer concerned and changed into heat energy. For this reason, this heat energy has a bad influence on liquid crystal through the tubing light source or a light guide plate. What stated above is remarkable when smectic liquid crystals, such as antiferroelectricity liquid crystal which has a sensitive property to heat as liquid crystal especially, are used.
[0008] As JP,8-1582625,A shows, the incidence end face of a light guide plate is formed in the shape of toothing, and it is possible [it] to this, to control, for example so that the incident angle of the light to the incidence end face concerned may decrease the count of an interflection within a light guide plate. However, the fault of being difficult produces controlling the incident angle to the above-mentioned incidence end face of the light reflected by the reflector, even if it can control the above-mentioned incident angle in this case about the direct incident light from the tubing light source to the above-mentioned incidence end face for a location, a configuration, etc. over the tubing light source and the above-mentioned incidence end face of a reflector.
[0009] Moreover, although the example which left the flat surface the incidence end face of a light guide plate, and has arranged the prism-like transparency plate in parallel to the incidence end face concerned is indicated in the thing of the above-mentioned official report, the same fault as **** arises also by this. In addition, although the example which uses an optical member also for JP,8-94846,A or JP,8-54625,A is shown, the same fault as **** arises.
[0010] Therefore, to use the liquid crystal which is easy to be influenced of heat as liquid crystal of a liquid crystal panel, it is necessary to make structure of a reflector into the structure which is easy to diffuse heat in the relation between the tubing light source or a liquid crystal panel. Then, in order that this invention may cope with the above mentioned, it is adding a limit to the range of the incident angle over the incidence end face of the light guide plate of light so that the count of an interflection of the light within a light guide plate may be controlled to the minimum, and aims at offering the surface light source equipment of the structure of being hard to have effect by heat to the liquid crystal in a liquid crystal panel.
[0011]
[Means for Solving the Problem] With the surface light source equipment concerning invention according to claim 1 to 5, in solution of the above-mentioned technical problem The tubing light source which is arranged in the incidence end face (22) of the light guide plate (20) arranged along the rear face of a liquid crystal panel (10), and this light guide plate, and carries out outgoing radiation of the light to a radial (30), It is the reflector arranged so that the tubing light source concerned might be covered in the shape of cross-section abbreviation for U characters in accordance with the shaft orientations of this tubing light source, and has the reflector (40) which incidence is carried out and reflects light from the tubing light source. A light guide plate The light which carries out incidence to an incidence end face is introduced from the tubing light source and a reflector, and incidence is carried out to a liquid crystal panel from the rear face as sheet-like light.
[0012] It inclines so that it may be prepared so that more than one may be arranged to the shape of a saw-tooth wave in the direction in which the shaft of the tubing light source and an optical-system array (40c, 40d) cross at right angles the letter reflector of an inclination (42a) at each [which counters mutually among the internal surfaces of a reflector here] internal-surface section, respectively and it may become, and the letter reflector of each inclination may turn the light from the tubing light source to a reflector to an incidence end face and it may reflect.
[0013] And when incidence of the reflected light by each letter reflector of an inclination is carried out to an incidence end face, the tilt angle of each reflector is set up according to the width of face of

an incidence end face, and the distance from the incidence end face concerned so that this incident light may restrict the count by which an interflection is carried out within a light guide plate to the minimum. Thus, since the count of an interflection within the light guide plate concerned of the light which carried out incidence from the incidence end face into the light guide plate is restricted to the minimum, the absorption of light within a light guide plate is controlled to the minimum. For this reason, the bad influence by the heat of a light guide plate does not arise to the liquid crystal of a liquid crystal panel.

[0014] Here, according to invention according to claim 2, each optical array consists of two or more prism (42) which is arranged in the direction which intersects perpendicularly with the shaft of the tubing light source, and has a letter reflector of an inclination, respectively. Moreover, the letter reflector of an inclination of each [these] prism (42a) has a tilt angle according to the array location of each prism concerned.

[0015] According to this, the operation effectiveness of invention according to claim 1 is securable. Moreover, you may be the optical interference component for which each optical array has two or more letter interference fringe sides of an inclination equivalent to two or more letter reflectors of an inclination (43) like invention according to claim 3. Moreover, each optical array may be a diffraction grating or a hologram like invention according to claim 4.

[0016] Moreover, the effect of the heat of a light guide plate to the smectic liquid crystal concerned can be prevented certainly, securing the operation effectiveness of invention according to claim 1 to 4 like invention according to claim 5, even if the liquid crystal of a liquid crystal panel is a smectic liquid crystal.

[0017]

[Embodiment of the Invention] Hereafter, each operation gestalt of this invention is explained based on a drawing.

(The 1st operation gestalt) Drawing 1 shows the outline cross section of the liquid crystal display which comes to apply this invention. This liquid crystal display is equipped with the liquid crystal panel 10 which enclosed antiferroelectricity liquid crystal, and surface light source equipment S.

[0018] Surface light source equipment S is equipped with the light guide plate 20, the cold cathode discharge tube 30, and the reflector 40. The light guide plate 20 is arranged by the liquid crystal panel 10 along that rear face on that top face 21, and this light guide plate 20 introduces the light of a cold cathode discharge tube 30 from that incidence end face 22, and it carries out incidence to a liquid crystal panel 10 from that rear face as uniform sheet-like light. In addition, sign 20a shows the light reflex diffusion sheet formed in the base of a light guide plate 20 by drawing 1 .

[0019] As drawing 1 and drawing 2 show a cold cathode discharge tube 30, it is arranged along with the incidence end face 22 of a light guide plate 20, and this cold cathode discharge tube 30 carries out incidence of the linear light to the incidence end face 22 of a light guide plate 20. The reflector 40 equips the inside of semicircle cylinder part 40a, both parallel part 40b which extends in parallel mutually from both the edges of this semicircle cylinder part 40a, and both [these] parallel part 40b with prism array 40c formed, respectively, as drawing 1 and drawing 2 show. In addition, the internal surface of body 40a plays a role of a reflector (it functions as a parabolic mirror).

[0020] Both parallel part 40b has fixed in the illustration left end section in drawing 1 and drawing 2 of a light guide plate 20 at each of that extension edge 41. Moreover, the core of the semicircle-like cross section of semicircle cylinder part 40a has countered in the center of the width of face (the direction width of face of board thickness of a light guide plate 20) of the incidence end face 22 of a light guide plate 20. For this reason, the internal-surface diameter of semicircle cylinder part 40a is equal to the width of face of the incidence end face 22. Thereby, a reflector 40 is effective in prevention of leakage of the incidence end face 22 of the next door, alias a wrap, and light. Consequently, the incidence effectiveness of the light of a cold cathode discharge tube 30 to the incidence end face 22 can be raised.

[0021] Here, the axial center of a cold cathode discharge tube 30 is located in an illustration left in drawing 1 rather than the core of semicircle cylinder part 40a so that I may be understood from drawing 2 . Moreover, the axial center of a cold cathode discharge tube 30 is located on the radius line P of semicircle cylinder part 40a which passes along the center of the cross direction in the incidence end face 22 of a light guide plate 20. And in order to utilize effectively the outgoing

radiation light of a cold cathode tube 30, it is necessary to fill the several 1 following formula.
[0022]
[Equation 1] Theta=tan -1 (D/2L)
However, theta expresses the outgoing radiation angle with the radius line P of the outgoing radiation light of a cold cathode tube 30 to make. Moreover, D expresses the crosswise merit of the incidence end face 22 of a light guide plate 20, and the maximum of this outgoing radiation angle theta is 50 degrees. Moreover, L expresses the distance between the axial center of a cold cathode tube 30, and the incidence end face of a light guide plate 20.
[0023] The angle of refraction in the incidence end face 22 concerned of the direct incident light from the cold cathode tube 30 to the incidence end face 22 of a light guide plate 20 has low counts of an interflection of the incident light [one / smaller possible] in a light guide plate 20. For this reason, it is required that the crosswise merit D who distance L Reaches should be made small. To the radius line P, it is located symmetrically and both prism array 40c has a symmetrical configuration. Drawing 2 explains per the configuration taking the case of prism array 40c located in the illustration bottom.
[0024] Prism array 40c is equipped with two or more pillar-shaped rectangular prisms 42. Array formation is carried out along with the internal surface of top parallel part 40b of a reflector 40, covering [each / these / 42] it over the right end section from the illustration left end section in drawing 2 , and the longitudinal direction of each [these] rectangular prism 42 serves as a right angle crosswise [of a light guide plate 20]. Here, the configuration of each rectangular prism of prism array 40c is explained.
[0025] In each rectangular prism 42 The angle of the base on top parallel part 40b, and letter reflector of inclination 42a (it is hereafter called a tilt angle) -- psi -- expressing -- the point Q on reflector 42a of the 1 rectangular prism 42, and the axial center (henceforth an axial center O) of a cold cathode tube 30 -- a passage -- a line (the distance between the following and parallel lines R -- La -- then) parallel to the incidence end face 22 The data (henceforth tilt-angle-distance data) showing the relation between the tilt angle psi and distance L are specified by the graph shown by drawing 3 . However, crosswise die-length D of the incidence end face 22 of a light guide plate 20 is set to 10mm, and it is referred to as refractive-index n1 =1 of air, and is referred to as refractive-index n2 =1.5 of a light guide plate 20. Moreover, angle of refraction phi when the light of the cold cathode tube 30 reflected the point Q on reflector 42a of the 1 rectangular prism 42 carries out incidence to the incidence end face 22 of a light guide plate 20 is made into 15 degrees.
[0026] Therefore, it is formed so that it may have the tilt angle psi specified as each rectangular prism 42 of prism array 40c is also for the above-mentioned tilt-angle-distance data according to distance L. Next, the derivation basis of the above-mentioned tilt-angle-distance data is explained. In drawing 2 , the tilt angle psi is expressed by the several 2 following formula using a Snell's law.
[0027]
[Equation 2]
psi= [theta-sin -1 {(n2 / n1) sinphi}]/2 -- here, the crosswise die length of the incidence end face 22 of a light guide plate 20 is set to D, and d, then D>>d are materialized in spacing between Point Q and top parallel part 40b. Therefore, the outgoing radiation angle theta is expressed by several 3 formula below in the relation between crosswise die-length D and distance La.
[0028]
[Equation 3] Theta=tan -1 (D/2La)
Therefore, the several 4 following formula is obtained from two above and both the formulas of several 3.
[0029]
[Equation 4] Only psi=[tan-1(D/2La)-sin-1{(n2 / n1) sinphi}] / 2 are carried out, and the graph of D= 10mm, n1 =1, n2 =1.5, phi= 15 degrees, then drawing 3 is obtained in this formula. That is, theta>tan - In the range of 1(D/2La) = 50 degrees, in order to restrict the incident angle over the incidence end face 22 of a light guide plate 20 with **25 maxes, it is needed for the tilt angle psi of each rectangular prism 42 to fulfill the value on the graph of drawing 4 in relation with distance La. In addition, since [which makes the refractive index of a light guide plate 20 about 1.5] it is above, with this operation gestalt, it is determined that the tilt angle psi will fill the graph of drawing 4

according to distance La, covering each rectangular prism 42 of prism array 40c over the rectangular prism at the right end of illustration from the rectangular prism at the left end of illustration in drawing 3 . In connection with this, the cross-section configuration of each rectangular prism 42 is also determined that it will have the tilt angle psi according to distance La. In addition, when a light guide plate 20 is a hollow-like thing, the incident angle over the incidence end face 22 is made into about **15 maxes.

[0030] In addition, prism array 40c of another side is constituted similarly. With the **** 1 operation gestalt constituted as mentioned above, if a cold cathode tube 30 carries out outgoing radiation of the light, this light will progress to a radial within a reflector 40. In this case, the outgoing radiation light of a cold cathode tube 30 is divided into the part which carries out direct incidence to the incidence end face 22 of a light guide plate 20, the part which carries out incidence to both prism array 40c, and the part which carries out incidence to semicircle cylinder part 40a of a reflector 40.

[0031] On condition that the optical part which carries out direct incidence to the incidence end face 22 of a light guide plate 20 fills several 1 formula, the count of an interflection within this light guide plate 20 after carrying out incidence into a light guide plate 20 can decrease sharply. Moreover, the optical part which carries out incidence to both prism array 40c is made as [fill / like **** / formation of each rectangular prism 42 of each prism array 40c / the graph of drawing 3]. Therefore, on condition that the optical part which carries out incidence to both prism array 40c fills several 4 formula, the count of an interflection within this light guide plate 20 after carrying out incidence into a light guide plate 20 can decrease sharply.

[0032] Moreover, since semicircle cylinder part 40a of a reflector 40 is located behind a cold cathode tube 30, after being reflected by the semicircle cylinder part 40a concerned, incidence of the optical part which carries out incidence to semicircle cylinder part 40a is carried out to the incidence end face 22 of a light guide plate 20 at an include angle smaller than the optical part which carries out direct incidence at the incidence end face 22 of a light guide plate 20. For this reason, the angle of refraction in the incidence end face 22 is very small.

[0033] Therefore, the count within the light guide plate 20 concerned which carries out an interflection can decrease [the light which carried out incidence into the light guide plate 20 among the outgoing radiation light of a cold cathode tube 30] sharply. Therefore, the amount which the outgoing radiation light of a cold cathode tube 30 transforms to heat energy within a light guide plate 20 decreases very much. Consequently, an absorbed amount decreases as heat energy of a light guide plate 20, this heat energy gets across to a liquid crystal panel 10, and it does not have a bad influence on that antiferroelectricity liquid crystal. Such a thing is the same even when optical diffuse reflection layer 20a absorbs the light in a light guide plate 20.

[0034] Moreover, the angle of refraction in the incidence end face 22 is very small like ****. Therefore, the count of an interflection of light [/ near the incidence end face 22 within a light guide plate 20] decreases very much, consequently the brightness of the outgoing radiation side of the light of a light guide plate 20, i.e., the screen of a liquid crystal panel 10, can be made into homogeneity.

(The 2nd operation gestalt) Drawing 4 shows the 2nd operation gestalt of this invention.

[0035] With this 2nd operation gestalt, as drawing 4 shows, extension formation of each rectangular prism 42 of the reflector 40 stated with the above-mentioned 1st operation gestalt is carried out bordering on the radius line P to semicircle cylinder part 40a of a reflector 40. Other configurations are the same as that of the above-mentioned 1st operation gestalt. Thus, in the constituted **** 2 operation gestalt, extended formation of each prism array 40c is carried out to semicircle cylinder part 40a of a reflector 40 like ****.

[0036] Thereby, the operation effectiveness of the above-mentioned 1st operation gestalt can be improved further.

(The 3rd operation gestalt) Drawing 5 shows the important section of the 3rd operation gestalt of this invention. With this 3rd operation gestalt, the reflector 40 and cold cathode tube 30 which were stated with the above-mentioned 1st operation gestalt are similarly formed not only in the illustration left-hand side incidence end face 22 (it is the same as the incidence end face 22 stated with the above-mentioned 1st operation gestalt) but in the right-hand side incidence end face 23 of a light

guide plate 20 in drawing 5 of a light guide plate 20. In addition, sign 10a shows a diffusion sheet by drawing 5 . Other configurations are the same as that of the above-mentioned 1st operation gestalt.
[0037] Thus, with the constituted **** 3 operation gestalt, the reflector 40 and the cold cathode tube 30 are formed also in the incidence end face 23 of a light guide plate 20. Consequently, the operation effectiveness taken by drawing 1 can be generated effectively.
(The 4th operation gestalt) Drawing 6 shows the important section of the 4th operation gestalt of this invention.
[0038] With this 4th operation gestalt, reflective diffusion sheet 10b, condensing [both] sheet 10c, and polarization reflective sheet 10d are infixed between the light guide plates 20 and liquid crystal panels 10 which were stated with the above-mentioned 1st operation gestalt. This can also attain the same operation effectiveness as the above-mentioned 1st operation gestalt.
(The 5th operation gestalt) Drawing 7 shows the important section of the 5th operation gestalt of this invention.
[0039] With this 5th operation gestalt, each volume template-like hologram 40d (drawing 7 shows only one hologram 40d) replaces with each prism array 40c stated with the above-mentioned 1st operation gestalt, and is prepared in the internal surface of each parallel Itabe 40b of a reflector 40. It comes to cost each hologram 40d array formation, applying each laminating-like interference fringe sides 43 of two or more to right-hand side from illustration left-hand side in drawing 1 and drawing 7 in the shape of a saw-tooth wave in the optical component, and each [these] interference fringe side 43 is equivalent to letter reflector of inclination 42a of the prism 42 stated with the above-mentioned 1st operation gestalt.
[0040] Here, tilt-angle psia of each interference fringe side 43 fills the several 5 following formula.
[0041]
[Equation 5] psia=A1-A2 -- here, A1 and A2 are include angles shown by drawing 7 , and these [A1 and A2] are given by the several 6 and several 7 following formula, respectively.
[0042]
[Equation 6]

$$A1 = (3/2)\ sin^{-1}\left\{\frac{n_3}{n_1} sin^{-1}(B1)\right\}$$

[0043]
[Equation 7]

$$A2 = \frac{1}{2} sin^{-1}\left\{\frac{n_3}{n_1} sin^{-1}(B2)\right\}$$

However, as drawing 7 shows, it is B1=90-theta. In addition, theta is the outgoing radiation angle stated with the above-mentioned 1st operation gestalt.
[0044] Moreover, B-2 is an include angle shown by drawing 7 , and this B-2 is expressed by the several 8 following formula.
[0045]
[Equation 8]

$$B2 = \left\{90 - sin\left(\frac{n_2}{n_1} sin\phi\right)\right\}$$

As mentioned above, if it sets up like the tilt angle psi which stated the above-mentioned tilt-angle psia with the above-mentioned 1st operation gestalt, even if it replaces with prism array 40c and adopts hologram 40d like this operation gestalt, the same operation effectiveness as the above-mentioned 1st operation gestalt can be attained. In addition, the other configurations and operation effectiveness are the same as the above-mentioned 1st operation gestalt.
[0046] In addition, in the above-mentioned 5th operation gestalt, although the example which

adopted hologram 40d was explained, even if it replaces with this and adopts a volume mold diffraction grating, the same operation effectiveness as the above-mentioned 5th operation gestalt can be attained. However, the interference fringe side of the above-mentioned volume mold diffraction grating is set up like a hologram 40d interference fringe side. Moreover, in operation of this invention, it may replace with a volume mold hologram or a volume mold diffraction grating, and an area mold hologram and an area mold diffraction grating may be adopted and carried out.
[0047] Moreover, the liquid crystal which is easy to be influenced of the heat of a smectic liquid crystal and others, such as a ferroelectric liquid crystal, may be used for the liquid crystal used for a liquid crystal panel 10 in operation of this invention, without restricting to antiferroelectricity liquid crystal. Moreover, in operation of this invention, it may replace with a cold cathode discharge tube 30, and various kinds of tubing light sources may be adopted and carried out.
[0048] Moreover, the prism stated with the above-mentioned 1st operation gestalt is not restricted to a rectangular prism in operation of this invention.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the partial fracture side elevation showing the 1st operation gestalt of this invention.
[Drawing 2] It is the typical important section expanded sectional view showing the arrangement relation between the cold cathode tube of drawing 1 , a reflector, and a light guide plate.
[Drawing 3] It is the graph which shows the relation between the tilt angle psi of each rectangular prism of the prism array of drawing 2 , and distance La.
[Drawing 4] It is the fragmentary sectional view showing the 2nd operation gestalt of this invention.
[Drawing 5] It is the partial fracture side elevation showing the 3rd operation gestalt of this invention.
[Drawing 6] It is the partial fracture side elevation showing the 4th operation gestalt of this invention.
[Drawing 7] It is the typical important section expanded sectional view showing the 5th operation gestalt of this invention.
[Description of Notations]
10 [-- A cold cathode discharge tube, 40 / -- A reflector, 40a / -- A semicircle cylinder part, 40b / -- A parallel part, 40c / -- A prism array, 42 / -- A rectangular prism, 42a / -- Reflector.] -- A liquid crystal panel, 20 -- 22 A light guide plate, 23 -- An incidence end face, 30

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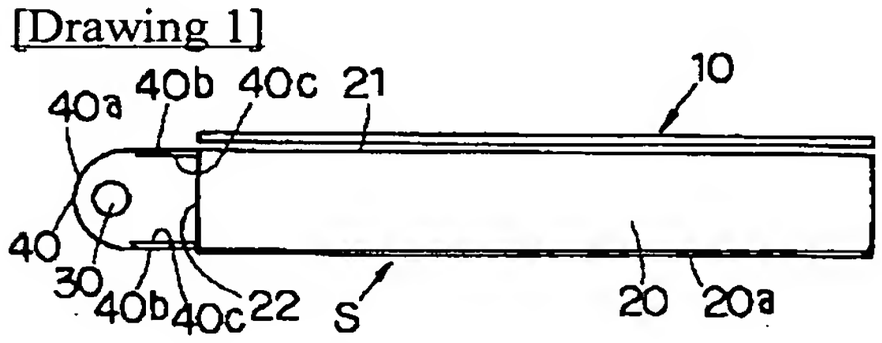
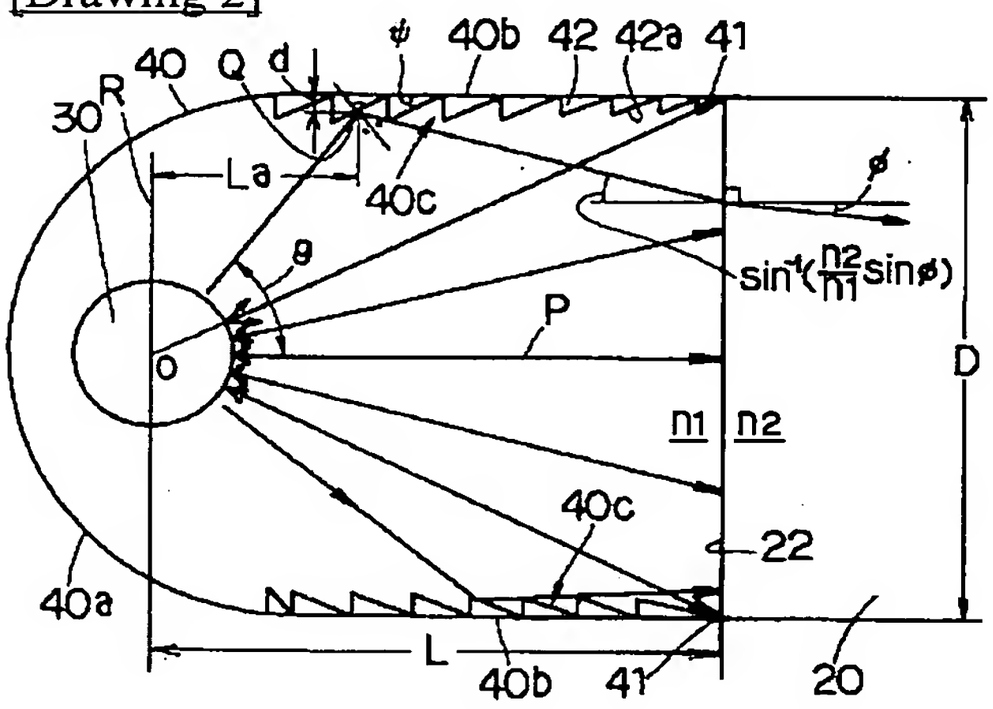
DRAWINGS

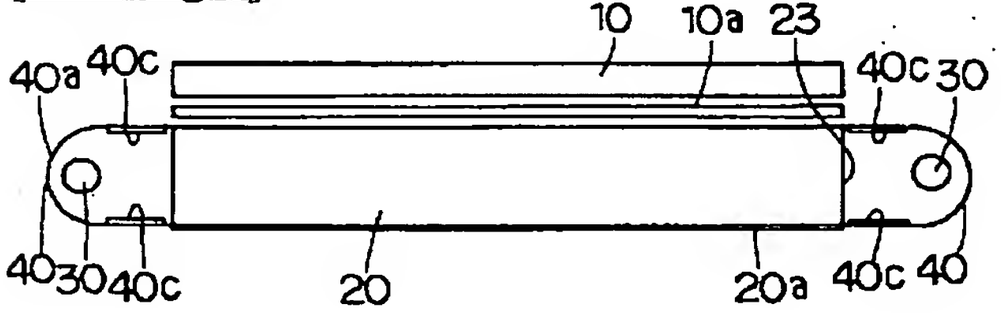
[Drawing 1]



[Drawing 2]



[Drawing 5]



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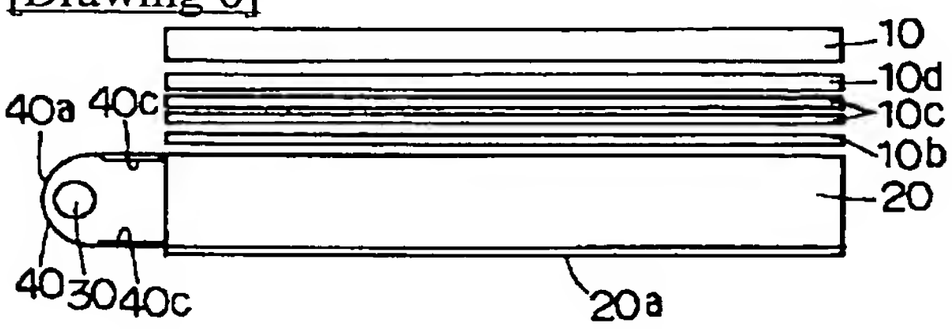

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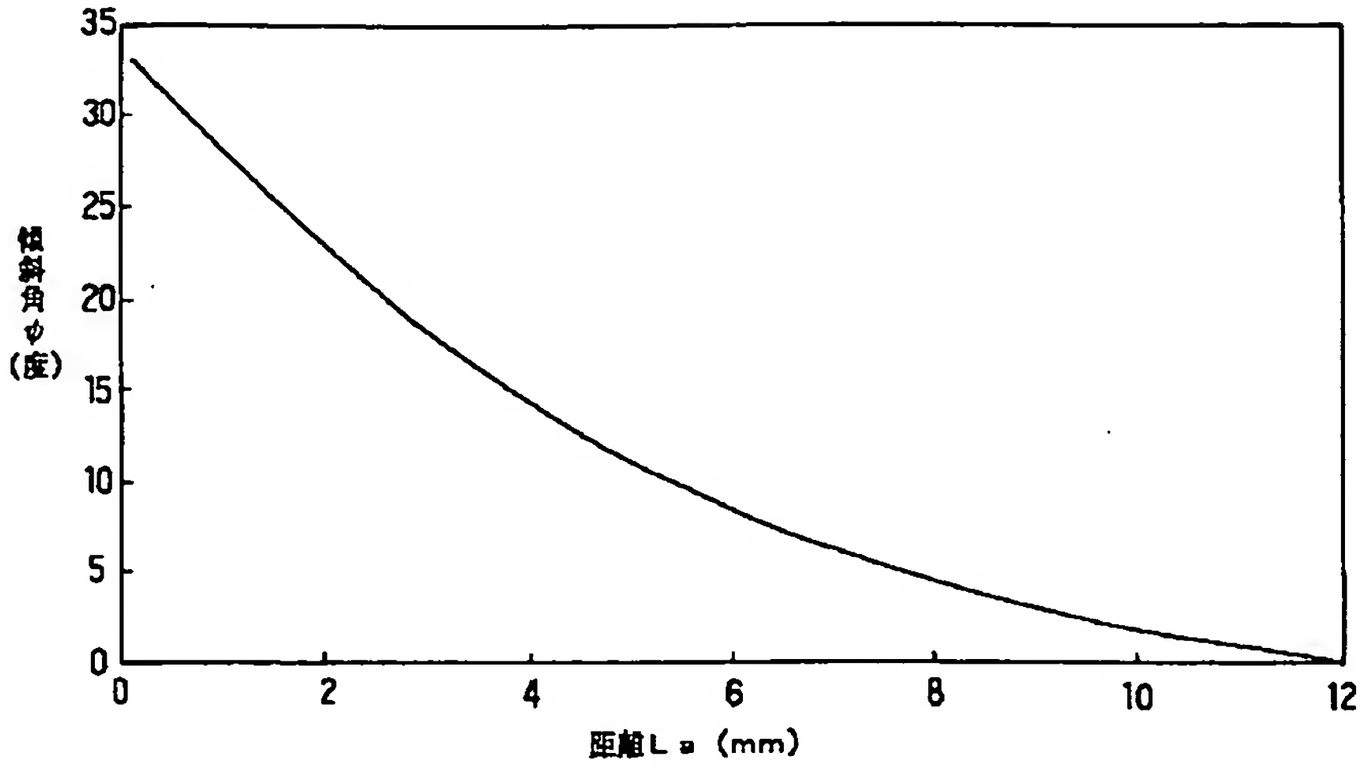

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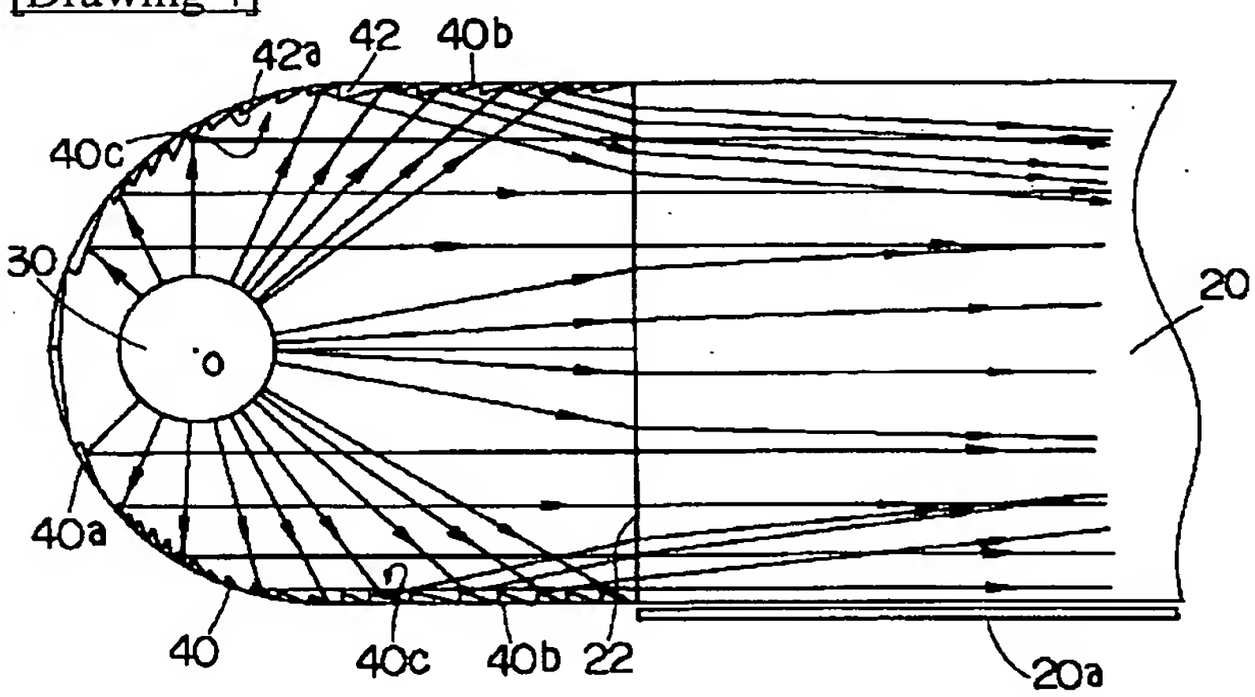

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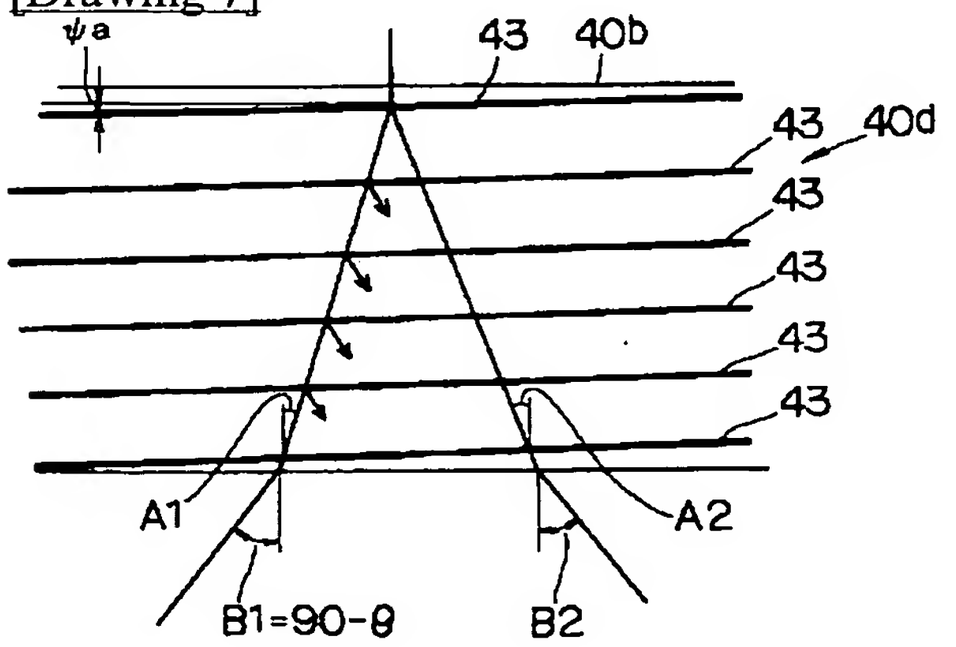

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SURFACE LIGHT SOURCE DEVICE FOR LIQUID CRYSTAL PANEL

Publication number: JP11258600
Publication date: 1999-09-24
Inventor: KUROKAWA KAZUMASA; TAKASU HISASHI
Applicant: DENSO CORP
Classification:
- international: ***G02F1/1335; F21V8/00; G02F1/13357;*** **F21V8/00; G02F1/13;** (IPC1-7): G02F1/1335; F21V8/00
- european:
Application number: JP19980058181 19980310
Priority number(s): JP19980058181 19980310

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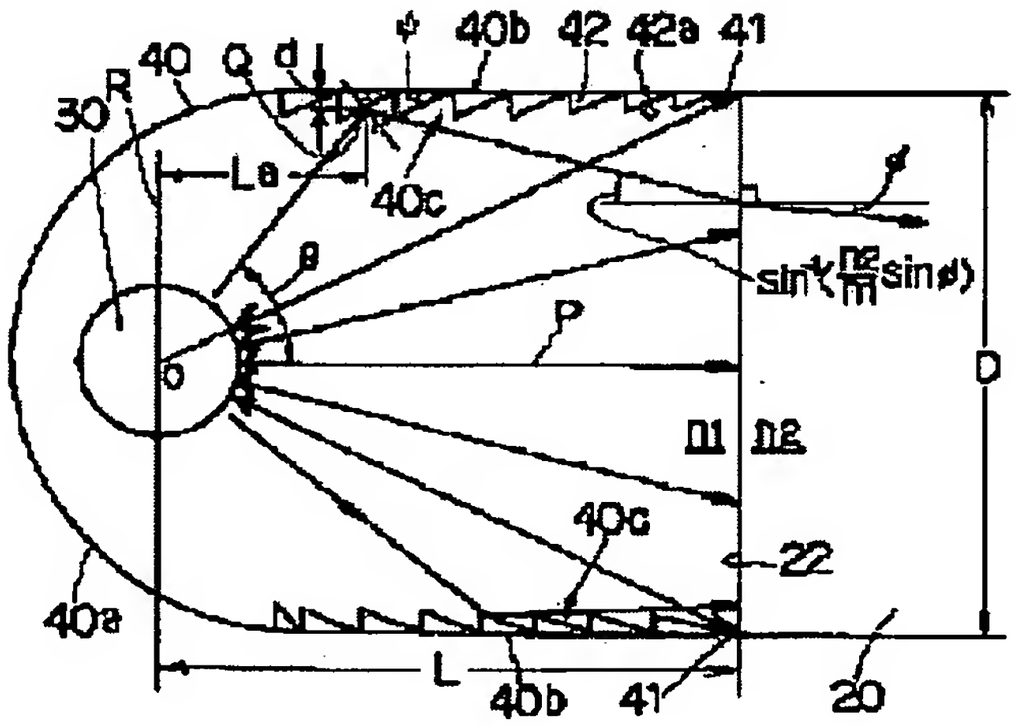
Abstract of **JP11258600**

PROBLEM TO BE SOLVED: To provide a surface light source with such a structure that hardly exerts thermal influence on liquid crystal in a liquid crystal panel by limiting a range of an incident angle to an incident end face of a light guide plate so that a mutual reflection frequency of light in the light guide plate is suppressed to the minimum. SOLUTION: A reflector 40 has both prism arrays 40c. Each of the prism arrays 40c is provided with plural rectangular prisms 42, and each rectangular prism 42 has a tilted reflecting surface 42a reflecting light of a cold cathode ray tube 30 onto an incident end face 22 of a light guide plate 20. Here, a tilt angle &psi of each reflecting surface 42a is set so that a mutual reflection frequency of the light reflected by each reflecting surface 42a and made incident on the incident end face 22 is suppressed to the minimum.



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(19)日本国特許庁（ＪＰ）　(12)**公開特許公報**（A）　(11)特許出願公開番号

特開平11－258600

(43)公開日　平成11年(1999)９月24日

(51)Int.Cl.[6]		識別記号	FI		
Ｇ０２Ｆ	1/1335	５３０	Ｇ０２Ｆ	1/1335	５３０
Ｆ２１Ｖ	8/00	６０１	Ｆ２１Ｖ	8/00	６０１Ｆ

審査請求　未請求　請求項の数５　ＯＬ　（全７頁）

(21)出願番号　特願平10－58181

(22)出願日　平成10年(1998)３月10日

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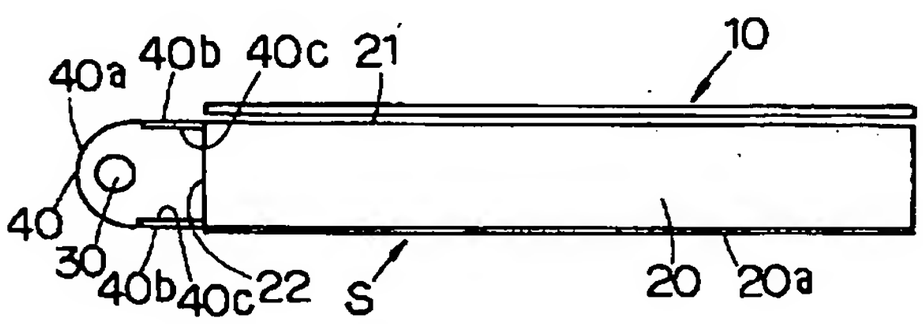
(54)【発明の名称】　液晶パネル用面光源装置

(57)【要約】
【目的】　導光板内での光の相互反射回数を最小限に抑制するように光の導光板の入射端面に対する入射角の範囲に制限を加えることで、液晶パネル内の液晶に対し熱による影響を与えにくい構造の面光源装置を提供する。
【解決手段】　リフレクタ４０は、両プリズムアレイ４０ｃを備えている。これた各プリズムアレイ４０ｃは、複数の直角プリスム４２を備えており、これら各直角プリスム４２は、冷陰極管３０の光を導光板２０の入射端面２２へ反射する傾斜状反射面４２ａを有する。ここで、各反射面４２ａにより反射されて入射端面２２に入射した光の導光板２０内での相互反射回数が最小限に制限されるように、各反射面４２ａの傾斜角Ψが設定されている。



【特許請求の範囲】
【請求項１】　液晶パネル（１０）の裏面に沿い配置された導光板（２０）と、
この導光板の入射端面（２２）に配設されて放射状に光を出射する管光源（３０）と、
この管光源の軸方向に沿い当該管光源を断面略Ｕ字状に覆うように配設されたリフレクタであって前記管光源から光を入射されて反射するリフレクタ（４０）とを備えて、
前記導光板は、前記管光源及び前記リフレクタから前記入射端面に入射する光を導入して面状光として前記液晶パネルにその裏面から入射するようにした面光源装置において、
前記リフレクタの内表面のうち互いに対向する各内表面部には、光学系アレイ（４０ｃ、４０ｄ）が、それぞれ、傾斜状反射面（４２ａ）を前記管光源の軸に直交する方向に鋸歯状波状に複数配列してなるように設けられており、
前記各傾斜状反射面は、前記管光源から前記リフレクタへの光を前記入射端面に向けて反射するように傾斜しており、
前記各傾斜状反射面による反射光が前記入射端面に入射されたときこの入射光が前記導光板内にて相互反射される回数を最小限に制限するように、前記各反射面の傾斜角が、前記入射端面の幅及び当該入射端面からの距離に応じて設定されていることを特徴とする液晶パネル用面光源装置。
【請求項２】　前記各光学的アレイは、前記管光源の軸に直交する方向に配列されて前記傾斜状反射面をそれぞれ有する複数のプリズム（４２）からなり、
これら各プリズムの傾斜状反射面（４２ａ）は、前記傾斜角を、当該各プリズムの配列位置に応じて有することを特徴とする請求項１に記載の液晶パネル用面光源装置。
【請求項３】　前記各光学的アレイが、前記複数の傾斜状反射面に相当する複数の傾斜状干渉縞面（４３）を有する光学干渉素子であることを特徴とする請求項１に記載の液晶パネル用面光源装置。
【請求項４】　前記各光学的アレイは回折格子或いはホログラムであることを特徴とする請求項３に記載の液晶パネル用面光源装置。
【請求項５】　前記液晶パネルは、スメクチック液晶を封入してなることを特徴とする請求項１乃至４のいずれか一つに記載の液晶パネル用面光源装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、スメクチック液晶等の熱の影響を受け易い液晶を用いる液晶パネルに採用するに適した面光源装置に関するものである。
【０００２】
【従来の技術】従来、この種の面光源装置においては、透過型液晶パネルの裏面に沿い導光板を配置し、この導光板の入射端面に沿い管光源を配置して、この管光源から導光板内にその入射端面から入射した光を、面状光として、液晶パネルに入射させるようにしたものがある。また、リフレクタを、管光源を覆うように配設して、このリフレクタの反射作用により管光源の出射光の導光板内への入射効率を高めるようにしてあるのが通常である。
【０００３】
【発明が解決しようとする課題】ところで、上記面光源装置では、導光板の面状光による輝度分布は液晶パネルの裏面全体に亘り均一にし得るものの、管光源内に入射された光の利用率が低い。この点につき詳細に検討してみると、管光源の光は、管光源の軸心を中心として放射状に３６０°方向に亘り均一に出射する。また、このように管光源から出射した光は、直接に、導光板の入射端面に入射するか、或いは、リフレクタにより反射された上で導光板の入射端面に入射する。
【０００４】ここで、導光板の入射端面に対する光の入射方向と当該入射端面に対する法線とのなす角、即ち入射角は、管光源と導光板の入射端面との間の空間的位置関係、当該入射端面の面積や、リフレクタの特性によって決定される。また、導光板の底面には、上記面状光の均一化のために、通常、光拡散処理層が形成されている。従って、導光板内にその入射端面から入射した光は、当該導光板内にて上記光拡散処理層の拡散反射作用のもと相互反射されながら進む。
【０００５】このような過程では、光量が、その相互反射１回につき数％ずつ減少していく。従って、上記入射角が大きい程、導光板内での光の相互反射回数も多くなり、当該導光板での光量の減少度合も著しい。その結果、光は、実質的に、導光板の当該光の進行方向中央までにしか到達しない。従って、導光板内に入射した光のうちその光量の減少分が導光板内にて吸収され熱エネルギーに変換されてしまい、この熱エネルギーが液晶パネルの液晶に悪影響を及ぼす要因となっている。
【０００６】また、導光板内では、上記入射角が大きい程、入射端面近傍での相互反射回数が多い。このため、導光板の入射端面近傍における光量の減少度合が高い。従って、導光板内では、入射端面近傍程、光の熱エネルギーへの変換割合が高い。よって、液晶パネルのうち導光板の入射端面に近い部分程、熱エネルギーの液晶に対する悪影響の度合が大きい。
【０００７】さらに、上記拡散処理層が、例えば、白インクの印刷層からなる場合には、光が当該印刷層により吸収されて熱エネルギーに変換される。このため、この熱エネルギーが、管光源や導光板を介し液晶に悪影響を及ぼす。以上述べたようなことは、特に、液晶として、熱に対し敏感な特性を有する反強誘電性液晶等のスメク

チック液晶を用いた場合に著しい。
【０００８】これに対しては、例えば、特開平８－１５８２６２５号公報にて示すように、導光板の入射端面を凹凸形状に形成して、当該入射端面に対する光の入射角を、導光板内での相互反射回数を減少させるように、抑制することが考えられる。しかし、この場合、管光源から上記入射端面への直接入射光については、上記入射角を抑制することができても、リフレクタにより反射された光の上記入射端面への入射角を抑制することは、リフレクタの管光源や上記入射端面に対する位置や形状等のため、困難であるという不具合が生ずる。
【０００９】また、上記公報のものでは、導光板の入射端面を平面のままにして、当該入射端面にプリズム状透過板を平行に配置した例が開示されているが、これによっても、上述と同様の不具合が生ずる。なお、特開平８－９４８４６号公報や特開平８－５４６２５号公報にも、光学部材を用いる例が示されているが、上述と同様の不具合が生ずる。
【００１０】従って、液晶パネルの液晶として熱の影響を受けやすい液晶を用いる場合には、リフレクタの構造を管光源や液晶パネルとの関係において熱を拡散し易い構造とする必要がある。そこで、本発明は、以上のようなことに対処するため、導光板内での光の相互反射回数を最小限に抑制するように光の導光板の入射端面に対する入射角の範囲に制限を加えることで、液晶パネル内の液晶に対し熱による影響を与えにくい構造の面光源装置を提供することを目的とする。
【００１１】
【課題を解決するための手段】上記課題の解決にあたり、請求項１乃至５に記載の発明に係る面光源装置では、液晶パネル（１０）の裏面に沿い配置された導光板（２０）と、この導光板の入射端面（２２）に配設されて放射状に光を出射する管光源（３０）と、この管光源の軸方向に沿い当該管光源を断面略Ｕ字状に覆うように配設されたリフレクタであって管光源から光を入射されて反射するリフレクタ（４０）とを備え、導光板は、管光源及びリフレクタから入射端面に入射する光を導入して面状光として液晶パネルにその裏面から入射する。
【００１２】ここで、リフレクタの内表面のうち互いに対向する各内表面部には、光学系アレイ（４０ｃ、４０ｄ）が、それぞれ、傾斜状反射面（４２ａ）を管光源の軸に直交する方向に鋸歯状波状に複数配列してなるように設けられており、各傾斜状反射面は、管光源からリフレクタへの光を入射端面に向けて反射するように傾斜している。
【００１３】そして、各傾斜状反射面による反射光が入射端面に入射されたときこの入射光が導光板内にて相互反射される回数を最小限に制限するように、各反射面の傾斜角が、入射端面の幅及び当該入射端面からの距離に応じて設定されている。このように、導光板内にその入射端面から入射した光の当該導光板内での相互反射回数が最小限に制限されるから、導光板内での光の吸収が最小限に抑制される。このため、液晶パネルの液晶に対し導光板の熱による悪影響が生ずることがない。
【００１４】ここで、請求項２に記載の発明によれば、各光学的アレイは、管光源の軸に直交する方向に配列されて傾斜状反射面をそれぞれ有する複数のプリズム（４２）からなる。また、これら各プリズムの傾斜状反射面（４２ａ）は、傾斜角を、当該各プリズムの配列位置に応じて有する。
【００１５】これによれば、請求項１に記載の発明の作用効果を確保できる。また、請求項３に記載の発明のように、各光学的アレイが、複数の傾斜状反射面に相当する複数の傾斜状干渉縞面（４３）を有する光学干渉素子であってもよい。また、請求項４に記載の発明のように、各光学的アレイは回折格子或いはホログラムであってもよい。
【００１６】また、請求項５に記載の発明のように、液晶パネルの液晶がスメクチック液晶であっても、請求項１乃至４に記載の発明の作用効果を確保しつつ、当該スメクチック液晶に対する導光板の熱の影響を確実に防止できる。
【００１７】
【発明の実施の形態】以下、本発明の各実施形態を図面に基づいて説明する。
（第１実施形態）図１は本発明を適用してなる液晶表示装置の概略断面を示している。この液晶表示装置は、反強誘電性液晶を封入した液晶パネル１０と、面光源装置Ｓとを備えている。
【００１８】面光源装置Ｓは、導光板２０、冷陰極放電管３０及びリフレクタ４０を備えている。導光板２０は、その上面２１にて、液晶パネル１０にその裏面に沿い配設されており、この導光板２０は、その入射端面２２から冷陰極放電管３０の光を導入して均一な面状光として液晶パネル１０にその裏面から入射する。なお、図１にて、符号２０ａは、導光板２０の底面に形成した光反射拡散シートを示す。
【００１９】冷陰極放電管３０は、図１及び図２にて示すごとく、導光板２０の入射端面２２に沿い配設されており、この冷陰極放電管３０は、導光板２０の入射端面２２に線状の光を入射する。リフレクタ４０は、図１及び図２にて示すごとく、半円筒部４０ａと、この半円筒部４０ａの両縁から互いに平行に延出する両平行部４０ｂと、これら両平行部４０ｂの内面にそれぞれ形成したプリズムアレイ４０ｃとを備えている。なお、円筒部４０ａの内表面は反射面（放物面鏡として機能する）としての役割を果たす。
【００２０】両平行部４０ｂは、その各延出端部４１にて、導光板２０の図１及び図２にて図示左端部に固着されている。また、半円筒部４０ａの半円状断面の中心

は、導光板２０の入射端面２２の幅（導光板２０の板厚方向幅）の中央に対向している。このため、半円筒部４０ａの内表面直径は、入射端面２２の幅に等しい。これにより、リフレクタ４０が入射端面２２を覆うこととなり、光の漏洩の防止に有効である。その結果、入射端面２２に対する冷陰極放電管３０の光の入射効率を高めることができる。

【００２１】ここで、冷陰極放電管３０の軸心は、図２から理解されるように、半円筒部４０ａの中心よりも、図１にて図示左方に位置している。また、冷陰極放電管３０の軸心は、導光板２０の入射端面２２に幅方向中央を通る半円筒部４０ａの半径線Ｐ上に位置している。そして、冷陰極管３０の出射光を有効に活用するためには、次の数１の式を満たす必要がある。

【００２２】

【数１】$\theta = \tan^{-1}(D/2L)$

但し、θは、冷陰極管３０の出射光の半径線Ｐとのなす出射角を表す。また、Ｄは、導光板２０の入射端面２２の幅方向長を表しており、この出射角θの最大値は、例えば、５０度である。また、Ｌは、冷陰極管３０の軸心と導光板２０の入射端面との間の距離を表す。

【００２３】冷陰極管３０から導光板２０の入射端面２２への直接入射光の当該入射端面２２での屈折角はできるだけ小さい方が、導光板２０内における入射光の相互反射回数が少ない。このため、距離Ｌ及びの幅方向長Ｄを小さくすることが要求される。両プリズムアレイ４０ｃは、半径線Ｐに対し対称的に位置しかつ対称的な構成を有する。図２にて図示上側に位置するプリズムアレイ４０ｃを例にとりその構成につき説明する。

【００２４】プリズムアレイ４０ｃは、複数の柱状直角プリズム４２を備えている。これら各直角プリズム４２は、リフレクタ４０の上側平行部４０ｂの内表面に沿い図２にて図示左端部から右端部にかけて配列形成されており、これら各直角プリズム４２の長手方向は、導光板２０の幅方向に直角となっている。ここで、プリズムアレイ４０ｃの各直角プリズムの構成について説明する。

【００２５】各直角プリズム４２において上側平行部４０ｂ上の底面と傾斜状反射面４２ａとの角（以下、傾斜角という）をΨで表し、一直角プリズム４２の反射面４２ａ上の点Ｑと冷陰極管３０の軸心（以下、軸心Ｏという）を通り入射端面２２に平行な線（以下、平行線Ｒとの間の距離をＬａとすれば、傾斜角Ψと距離Ｌとの関係を表すデータ（以下、傾斜角－距離データという）は、図３にて示すグラフにより特定される。但し、導光板２０の入射端面２２の幅方向長さＤを１０ｍｍとし、空気の屈折率n_1＝１とし、導光板２０の屈折率n_2＝１．５とする。また、一直角プリズム４２の反射面４２ａ上の点Ｑにて反射される冷陰極管３０の光が導光板２０の入射端面２２に入射したときの屈折角ϕを１５度とする。

【００２６】従って、プリズムアレイ４０ｃの各直角プリズム４２は、上記傾斜角－距離データでもって特定される傾斜角Ψを距離Ｌに応じて有するように形成されている。次に、上記傾斜角－距離データの導出根拠について説明する。図２において、傾斜角Ψは、スネルの法則を用いて、次の数２の式により表される。

【００２７】

【数２】$\Psi = [\theta - \sin^{-1}\{(n_2/n_1)\sin\phi\}]/2$

ここで、導光板２０の入射端面２２の幅方向長さをＤとし、また、点Ｑと上側平行部４０ｂとの間の間隔をｄとすれば、Ｄ≫ｄが成立する。従って、出射角θは、幅方向長さＤ及び距離Ｌａとの関係において、次に数３の式により表される。

【００２８】

【数３】$\theta = \tan^{-1}(D/2La)$

よって、上記数２及び数３の両式から次の数４の式が得られる。

【００２９】

【数４】$\Psi = [\tan^{-1}(D/2La) - \sin^{-1}\{(n_2/n_1)\sin\phi\}]/2$

しかして、この式において、Ｄ＝１０ｍｍ、n_1＝１、n_2＝１．５、ϕ＝１５度とすれば、図３のグラフが得られる。つまり、$\theta > \tan^{-1}(D/2La)$＝５０度の範囲において、導光板２０の入射端面２２に対する入射角を、例えば、最大±２５度と制限するには、各直角プリズム４２の傾斜角Ψは、距離Ｌａとの関係において、図４のグラフ上の値を満たすことが必要とされる。なお、導光板２０の屈折率は例えば１．５程度とする以上のようなことから、本実施形態では、プリズムアレイ４０ｃの各直角プリズム４２は、図３にて図示左端の直角プリズムから図示右端の直角プリズムにかけて、傾斜角Ψが距離Ｌａに応じて図４のグラフを満たすように決定されている。これに伴い、各直角プリズム４２の断面形状も距離Ｌａに応じた傾斜角Ψを有するように決定されている。なお、導光板２０が中空状のものである場合には、入射端面２２に対する入射角を最大±１５度程度とする。

【００３０】なお、他方のプリズムアレイ４０ｃも、同様に構成されている。以上のように構成した本第１実施形態では、冷陰極管３０が光を出射すると、この光は、リフレクタ４０内にて放射状に進む。この場合、冷陰極管３０の出射光は、導光板２０の入射端面２２に直接入射する部分と、両プリズムアレイ４０ｃに入射する部分と、リフレクタ４０の半円筒部４０ａに入射する部分とに分かれる。

【００３１】導光板２０の入射端面２２に直接入射する光部分は、数１の式を満たすことを条件に、導光板２０内に入射した後のこの導光板２０内での相互反射回数が大幅に減少され得る。また、両プリズムアレイ４０ｃに

入射する光部分は、各プリズムアレイ４０ｃの各直角プリズム４２の形成が、上述のごとく、図３のグラフを満たすようになされている。従って、両プリズムアレイ４０ｃに入射する光部分は、数４の式を満たすことを条件に、導光板２０内に入射した後のこの導光板２０内での相互反射回数が大幅に減少され得る。

【００３２】また、リフレクタ４０の半円筒部４０ａは冷陰極管３０の後方に位置しているから、半円筒部４０ａに入射する光部分は、当該半円筒部４０ａにより反射された後、導光板２０の入射端面２２に、導光板２０の入射端面２２に直接入射する光部分よりも小さな角度にて入射する。このため、入射端面２２での屈折角は非常に小さい。

【００３３】従って、冷陰極管３０の出射光のうち導光板２０内に入射した光が当該導光板２０内での相互反射する回数が大幅に減少し得る。よって、冷陰極管３０の出射光が導光板２０内にて熱エネルギーに変換させる量が非常に少なくなる。その結果、導光板２０の熱エネルギーとして吸収量が少なくなり、この熱エネルギーが液晶パネル１０に伝わってその反強誘電性液晶に悪影響を与えることがない。このようなことは、光拡散反射層２０ａが導光板２０内の光を吸収する場合でも同様である。

【００３４】また、上述のごとく、入射端面２２での屈折角は非常に小さい。従って、導光板２０内での入射端面２２の近傍における光の相互反射回数が非常に少なくなり、その結果、導光板２０の光の出射面、即ち、液晶パネル１０の表示面の輝度を均一にし得る。

（第２実施形態）図４は、本発明の第２実施形態を示している。

【００３５】この第２実施形態では、上記第１実施形態にて述べたリフレクタ４０の各直角プリズム４２が、図４にて示すごとく、リフレクタ４０の半円筒部４０ａまで、半径線Ｐを境界として延出形成されている。その他の構成は上記第１実施形態と同様である。このように構成した本第２実施形態においては、各プリズムアレイ４０ｃが、上述のごとく、リフレクタ４０の半円筒部４０ａまで延長形成されている。

【００３６】これにより、上記第１実施形態の作用効果をより一層向上できる。

【００４３】

但し、図７にて示すごとく、Ｂ１＝９０－θである。なお、θは上記第１実施形態にて述べた出射角である。

【００４４】また、Ｂ２は、図７にて示す角度であり、

（第３実施形態）図５は、本発明の第３実施形態の要部を示している。この第３実施形態では、上記第１実施形態にて述べたリフレクタ４０及び冷陰極管３０が、導光板２０の図５にて図示左側入射端面２２（上記第１実施形態にて述べた入射端面２２と同じ）のみでなく、導光板２０の右側入射端面２３にも、同様に形成されている。なお、図５にて符号１０ａは、拡散シートを示す。その他の構成は上記第１実施形態と同様である。

【００３７】このように構成した本第３実施形態では、リフレクタ４０及び冷陰極管３０が、導光板２０の入射端面２３にも形成されている。その結果、図１にて示す作用効果を効果的に発生できる。

（第４実施形態）図６は、本発明の第４実施形態の要部を示している。

【００３８】この第４実施形態では、上記第１実施形態にて述べた導光板２０と液晶パネル１０との間に、反射拡散シート１０ｂ、両集光シート１０ｃ及び偏光反射シート１０ｄが介装されている。これによっても、上記第１実施形態と同様の作用効果を達成できる。

（第５実施形態）図７は、本発明の第５実施形態の要部を示している。

【００３９】この第５実施形態では、各体積型板状ホログラム４０ｄ（図７では、一方のホログラム４０ｄのみを示す）が、上記第１実施形態にて述べた各プリズムアレイ４０ｃに代えて、リフレクタ４０の各平行板部４０ｂの内表面に設けられている。各ホログラム４０ｄは、その光学的構成材料内に各複数の積層状干渉縞面４３を鋸歯状波状に図１及び図７にて図示左側から右側にかけて配列形成してなるもので、これら各干渉縞面４３は、上記第１実施形態にて述べたプリズム４２の傾斜状反射面４２ａに相当する。

【００４０】ここで、各干渉縞面４３の傾斜角Ψａは次の数５の式を満たす。

【００４１】

【数５】Ψａ＝Ａ１－Ａ２

ここで、Ａ１、Ａ２は、図７にて示す角度であり、これらＡ１、Ａ２は、それぞれ、次の数６、数７の式により与えられる。

【００４２】

【数６】

$$A1=(3/2)\sin^{-1}\left\{\frac{n_3}{n_1}\sin^{-1}(B1)\right\}$$

【数７】

$$A2=\frac{1}{2}\sin^{-1}\left\{\frac{n_3}{n_1}\sin^{-1}(B2)\right\}$$

このＢ２は、次の数８の式により表される。

【００４５】

【数８】

$$B2=\{90-\sin\left(\frac{n_2}{n_1}\sin\phi\right)\}$$

以上より、上記傾斜角Ψａを上記第１実施形態にて述べた傾斜角Ψと同様に設定すれば、本実施形態のように、プリズムアレイ４０ｃに代えてホログラム４０ｄを採用しても、上記第１実施形態と同様の作用効果を達成できる。なお、その他の構成及び作用効果は上記第１実施形態と同様である。

【００４６】なお、上記第５実施形態においては、ホログラム４０ｄを採用した例について説明したが、これに代えて、体積型回折格子を採用しても、上記第５実施形態と同様の作用効果を達成できる。但し、上記体積型回折格子の干渉縞面は、ホログラム４０ｄの干渉縞面と同様に設定する。また、本発明の実施にあたり、体積型ホログラムや体積型回折格子に代えて、面積型ホログラムや面積型回折格子を採用して実施してもよい。

【００４７】また、本発明の実施にあたり、液晶パネル１０に用いる液晶は、反強誘電性液晶に限ることなく、強誘電性液晶等のスメクチック液晶その他の熱の影響を受け易い液晶を採用してもよい。また、本発明の実施にあたり、冷陰極放電管３０に代えて、各種の管光源を採用して実施してもよい。

【００４８】また、本発明の実施にあたり、上記第１実施形態にて述べたプリズムは、直角プリズムに限ることはない。

【図面の簡単な説明】

【図１】本発明の第１実施形態を示す部分破断側面図である。

【図２】図１の冷陰極管、リフレクタ及び導光板の間の配置関係を示す模式的な要部拡大断面図である。

【図３】図２のプリズムアレイの各直角プリズムの傾斜角Ψと距離Ｌａとの関係を示すグラフである。

【図４】本発明の第２実施形態を示す部分断面図である。

【図５】本発明の第３実施形態を示す部分破断側面図である。

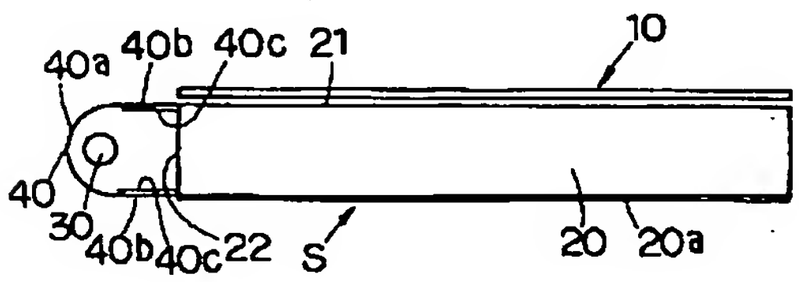
【図６】本発明の第４実施形態を示す部分破断側面図である。

【図７】本発明の第５実施形態を示す模式的な要部拡大断面図である。

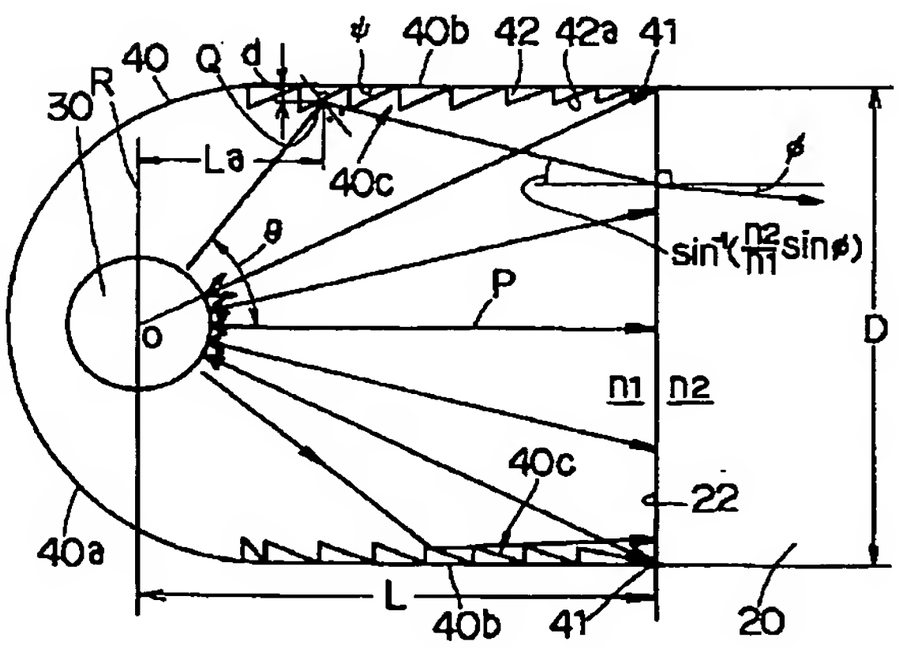
【符号の説明】

１０…液晶パネル、２０…導光板、２２、２３…入射端面、３０…冷陰極放電管、４０…リフレクタ、４０ａ…半円筒部、４０ｂ…平行部、４０ｃ…プリズムアレイ、４２…直角プリズム、４２ａ…反射面。

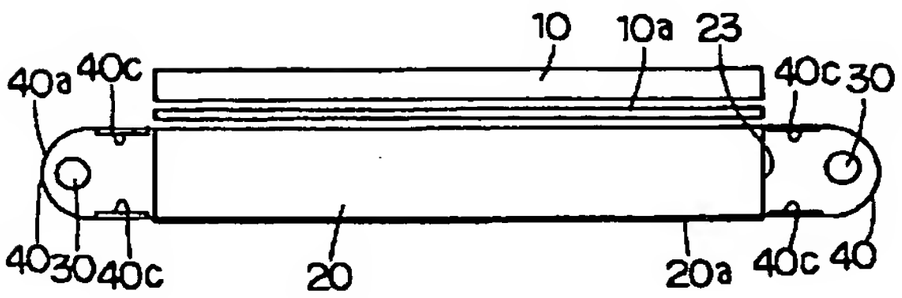
【図１】



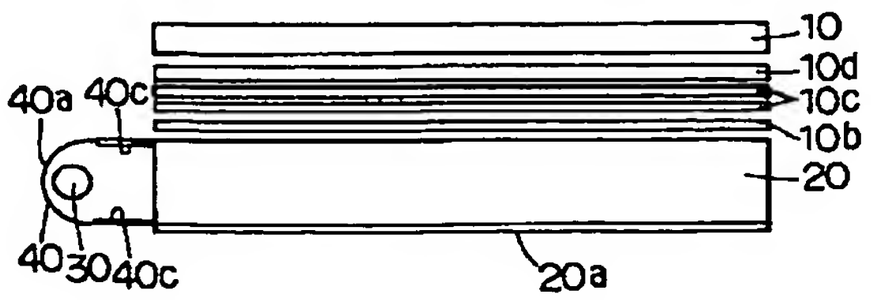
【図２】



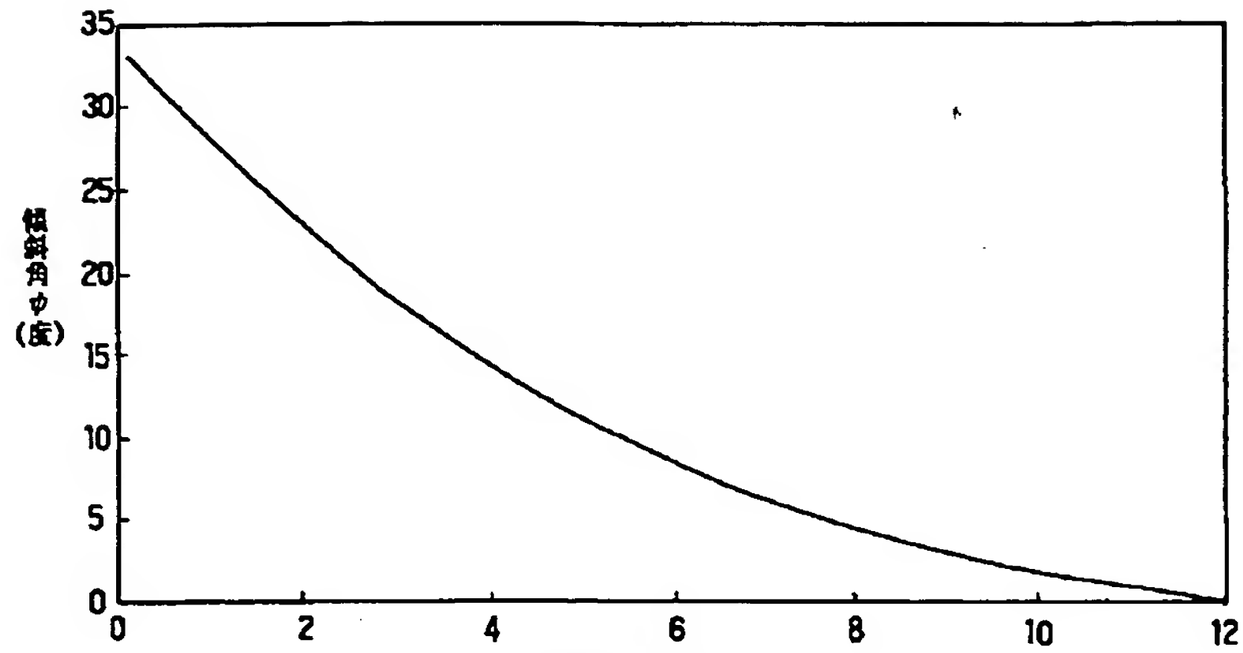
【図５】



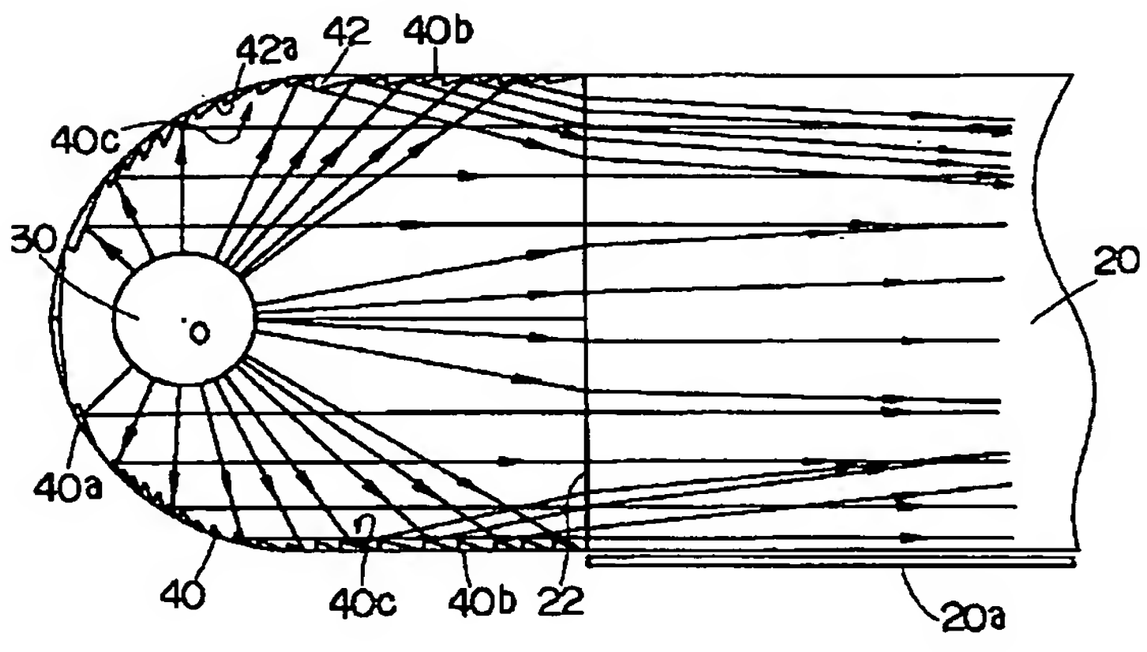
【図６】



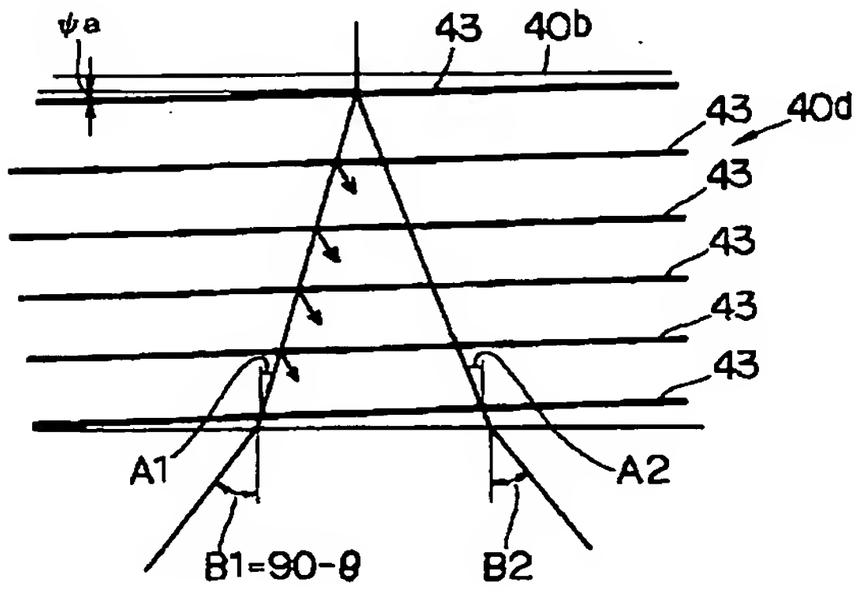
【図３】


35
30
25
20
15
10
5
0
0
2
4
6
8
10
12
ψ角度(度)
距離La (mm)

【図４】


42a
42
40b
40c
30
O
20
40a
40
40c
40b
22
20a

【図７】


ψa
43
40b
43
40d
43
43
43
43
A1
A2
B1=90-θ
B2